AVIATION EDUCATION FOR FUTURE AIRLINE PILOTS:
AN INTEGRATED MODEL

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ABSTRACT

Faced with an immediate shortage of qualified commercial pilots in the airlines, action must be taken for the commercial aviation industry to continue to maintain its dominance in the global economy. The U.S. major airlines, for example, will continue to step up their hiring of pilots away from the regional airlines, since the military resource of experienced pilots is simply no longer available in the numbers needed. If the regional airlines are to survive the short term as well as long term, they will be faced with hiring pilots with less flying hour experience than they have in the past. A key question in helping resolve the impact of this problem should be: *Can an enhanced aviation academic education and flight training program substitute for some of the current flight hours required for selection into the airlines*. In spite of the rapid evolution in the sophistication of modern aircraft and the increased complexity of the flight and navigation environment, aviation education methodology itself has changed very little over the years. This paper addresses aviation educational enhancements through the implementation of an integrated aviation learning model, the *Aviation Education Reinforcement Option (AERO)*. The AERO model incorporates elements of the adult education paradigm; learning style theory, including gender specific differences; cooperative and collaborative learning techniques; and personal computer-based flight simulator programs, to bridge the gap between the classroom and the flight line. The emphasis on the use of PC-based flight simulator programs is not aimed at reducing flight training or corresponding simulator training but is rather focused on providing immediate, hands-on application following each academic class to improve understanding and long-term retention and to increase knowledge application across a broader spectrum. Investment in implementing such an integrated aviation learning model, coupled with an early focus on airline type multi-crew procedures, has the potential to provide a high payoff in the quality of pilot production, which could accelerate the transition of relatively inexperienced pilots into airline cockpits.

INTRODUCTION

Projected shortages in the commercial pilot population, coupled with the length and cost of aviation training, suggest that aviation education and training institutions should re-examine the structure and organization of the aviation knowledge transfer process. Classroom enhancements could improve education methods to make them more efficient from the perspectives of increased knowledge retention, improved application to broader subjects, and reduced length of the time required for pilots to enter the commercial pilot workforce. This examination looks at how aviation education can best serve the learners' educational needs. The study also examines learning style theory, from the viewpoint of the wide diversity of aviation learners who are primarily visual, auditory, or hands-on learners and how women's learning styles are unique. By exploring how people learn best, and then providing those learners with an integrated approach toward aviation education, successor generation pilots should be better prepared to enter the aviation industry and help reduce the projected commercial pilot shortages.

BACKGROUND

A United States Department of Transportation Federal Advisory Committee study in 1993, directed by Congress, projected a shortage of qualified airline pilots which could impact the future availability of commercial air transportation in the United States. This study indicated that expansion of airline capacity, in combination with retirements from the airline pilot force and a reduced pool of former military pilots, would result in a national shortage of qualified pilots through 2010 unless positive actions were taken (United States Department of Transportation Federal Advisory Committee, 1993, pp. vii-xxiii, Appendix D, Table 1 and Table 4). Shortages in the major airlines, and the decreased resource of military trained pilots, has created an increased flow-through demand on the regional airlines for pilots, further impacting the regional airlines' training loads and experience levels.

Now with the long-discussed commercial pilot shortage a fact instead of a forecast, action must be taken immediately for the commercial aviation industry to continue to maintain its preeminence in the global marketplace. A pertinent commercial pilot supply issue to consider is that of the depth and quality of aviation academic education as well as the flight training of those future airline pilots. Because of the increasing sophistication of modern aircraft and high technology equipment, this topic underscores a need to examine, and restructure where necessary, the training options for potential airline pilots to ensure that the aviation education process is an in-depth, effective transfer of knowledge across a broad spectrum of aviation academic subjects. When considering aviation education, the academic component of the flight training plays an important role in providing the knowledge base for a new pilot. This academic education has the potential to build an exceptionally solid foundation for ensuring the high standard of technical and flying knowledge needed for future airline pilots.

One factor affecting the available commercial pilot pool may be the length of time it takes an aviation flight school graduate to attain the number of flying hours to apply for employment in the airlines. The typical "flight-time building path" for a new pilot involves flying first as an instructor pilot, and then as regional pilot; this path normally takes 6 to 8 years prior to applying for the major airlines. This historical emphasis on *flight hours* as an airline pilot selection criteria may be efficient when there is an adequate source of commercial pilots; however, an alternative approach, in light of the current pilots shortages, that could considered is that of a *proficiency-based flight training program*. This is similar to what the U.S. military and a number of foreign air carriers, such as Lufthansa German Airlines, employ (Karp, 1996).

Additionally, because of the relatively high cost of flight training, the need for comprehensive pilot screening and selection becomes increasingly important to assure that pilot candidates who meet all the rigid qualification requirements and have a high potential to succeed are selected for flight training leading to employment in the commercial sector. This selection process should be as specific as possible and emphasize intelligence, mechanical comprehension, and communication skills (United States Department of Transportation Federal Advisory Committee, 1993,

THEORETICAL UNDERPINNINGS

Adult Learning

While the term "adult learner" is often thought to only include persons seventeen or older who are not enrolled full-time in high school or college, the term adult learner in its broadest sense applies to every adult participating in organized education (Cross, 1979). In adult-focused aviation education, the extensive amount of technical material that must be covered for the course and the limited time available in the classroom, requires that every moment of educator-learner exposure be maximized. Aviation educators must motivate the learners, assure that they understand the importance of the self-learning process, and then facilitate the students' progress.

Adult Motivation. An important area to take into consideration in planning adult education programs is the learners' motives. The most important perspective in adult learning motivation is that adults are voluntary, practical learners who pursue education for its use to them. If education is to serve this voluntary learning force, then educators need to understand what to do to motivate their particular learners (Knowles, 1980). Studies indicate that adult learners appear to be very responsive and motivated to action-oriented learning, that is, learning while doing (Cross, 1979). Adults who are motivated, and see a need or have a desire to learn something new, are quite resourceful. The key to using adults' natural motivation to learn is tapping into their most teachable moments: those moments in their lives when they believe that they need to learn something different. The idea of this window of opportunity for learning applies not only to peoples' motivation to learn, but also to their ability to retain what they do learn. In contrast, if the learners acquire a new skill or knowledge, but then have no opportunity to use it or are delayed in using it, the skill or knowledge will fade (Zemke & Zemke, 1995).

Adult Education Facilitation. Noted adult educator Stephen Brookfield (1989) maintains that there are six principles of adult education facilitation which should be considered: First, adults voluntarily participate in the educational activity, and as such, the decision to learn is the learners'--they cannot be forced to learn. Second, there must be a mutual respect between the learner and the educator. Third, there must be a collaborative spirit in determining the course objectives, learning methods, and the evaluative process. Fourth, there must be a continuous process of investigation and exploration of the subject matter.

Fifth, time must be allotted for critical reflection. And sixth, the education must be self-directed by the learners, with the facilitator assisting the adults to reach their educational goals.

Although much of adult learning is self-directed, the classroom learning environment is still the critical link. Lecture alone is effective and essential when the learners have little or no knowledge of the subject matter. However, facilitation is more effective than lecture when the goal is to engage learners in setting objectives, to tap into their prior experience and knowledge, or to help the participants reach a consensus. Breaking participants into small learning groups to exercise new skills and knowledge in relative safety is critical to understanding and retention. Participants in an adult learning process are normally hesitant to try out new knowledge and skills in front of others. Small "praxis" teams that practice and reflect can overcome the reluctance to risk (Zemke & Zemke, 1995).

Cooperative and Collaborative Learning

In parallel with praxis teams and adult education, cooperative and collaborative learning techniques appear to be particularly applicable for aviation students. In *cooperative learning*, the students participate in small, structured group activities as they work together to solve problems assigned by the educator. By contrast, in *collaborative learning* the students are asked to organize their joint efforts and negotiate, among themselves, who will perform which task. The instructor does not always actively monitor the groups and refers all substantive questions back to them for resolution (Bruffee, 1995; Matthew, Cooper, Davidson & Hawkes, 1995).

Computer-Based Training

With the increased access to computer-based tutoring programs, students are moving away from passive reception of information to more active engagement in the acquisition of knowledge (Kozma & Johnston, 1991). Computer programs for tutoring technical subjects can be particularly useful in aviation education. Computer-Based Training (CBT) programs can be used extensively for pre-class preparation, as well as post-class review and reinforcement. CBT programs allow the student to accomplish self-paced learning in a non-threatening environment. In addition to supporting the CBT programs, the same basic computer equipment can be augmented with a control yoke and throttles to be used with personal computer-based flight simulator programs. These personal computer-based flight simulator programs are relatively low-cost training vehicles that can be easily and effectively integrated into an aviation education curriculum. They are well suited as an educational bridge between the basic, traditional aviation classroom and the advanced, high technology aviation flight environment (Karp, 1996). Additionally, personal computer-based training and flight simulator programs help provide the educational components in multiple learning styles, thereby meeting more individuals' learning needs than are provided by classroom lecture alone.

Learning Style Theory

Learning style theory, that is, the way people learn best, is of considerable importance in developing and delivering aviation academic programs. One model suggests that there are three recognized primary, or dominant, learning styles: First, *visual learners*, who learn best by reading or looking at pictures. Second, *auditory, or aural, learners*, who learn best by listening. And third, *hands-on, tactile, or kinesthetic learners*, who need to use their hands or whole body to learn (Filipczak, 1995). If knowledge transfer is to take place within the entire classroom population, all of these dominant learning styles should be addressed in the academic environment.

Gender also plays a role in learning style differences between aviation students in the classroom or on the flight line. Research has shown that women do not learn the same as men (Turney, 1995). For example, while men often prefer debate-like situations in which they pursue knowledge, women most frequently like to share and learn by interacting with each other (Tannen, 1990). Additionally, Females often are very participatory in their learning styles, while men tend to be more independent (Emanuel & Potter, 1992). Aviation curriculum development and delivery should take into consideration those learning styles that are unique to both men and women, in order to maximize their retention, and success, in the aviation career field.

In developing educational programs, it is important to know how people learn the best, and why they succeed. Because of the depth and complexity of the subject matter, aviation academic instructors must present the course material in ways that satisfy the different needs and styles of the aviation learners. Likewise, each student must understand his or her dominant learning style and maintain more focused attention to the information when it is being presented in a teaching style which is not easily compatible with their learning style.

Learning Style Research

To examine a representative sample of pilots' learning styles, interviews were conducted in three aviation groups to identify the respondents' dominant learning styles, as well as to explore potential enhancements and restructuring to aviation academic programs.

In the initial research group university aviation students were interviewed and their dominant learning style assessed. In the follow-up group, university aviation students were interviewed and then were administered a learning style assessment instrument. The third group of F-16 pilots, both students and instructor pilots, were also interviewed.

Students. In the initial assessment, over half of the students in an airline pilot focused class (n=15) in spring 1996 indicated, through self-assessment, that their dominant learning style was hands-on (tactile) learning (Table 1). The remainder was almost divided between auditory learners and visual learners. Of particular note is that most students did not realize that their most optimum way of learning might have been different from other students (Karp, 1996).

Learning Style	Number	Percentage
Visual	3	20.0%
Auditory	4	26.7%
Hands-on	8	53.3%

Table 1. Dominant learning styles for an airline pilot class (self-assessment).

Follow-on learning style research of aviation students (n=67) over a one-year period in fall 1998/spring 1999, using a learning style assessment instrument, reflected very similar results as the initial group (Table 2).

These students were also asked to self-identify their most dominant learning style prior to taking the assessment instrument. The results indicated that many students did not realize that they were predominantly hands-on learners; when in fact, 50.6% were either hands-on or hands-on/visual learners (Karp, 1996).

Learning Style	Pre-test number	Pre-test %	Post-test number	Post-test %
Visual	46	68.6%	26	38.8 %
Auditory	4	6.0%	4	6.0%
Hands-on	16	23.9%	27	40.3 %
Hands-on/Visual	1	1.5%	10	10.3 %

Table 2. Dominant learning styles for aviation students (interview and learning style instrument)

F-16 Pilots. During a separate research effort, U.S. Air Force F-16 pilots (n=35) were surveyed as to their learning style and the results were found to be consistent with the previous data, with over 60% of the respondents (Table 3) identifying that they were either hands-on or hands-on/visual learners (Karp, Condit, & Nullmeyer, 1999).

Learning Style	Number	Percentage
Visual	9	25.7%
Auditory	0	0
Hands-on	17	48.6%
Hands-on/Visual	6	17.1%
Visual/Auditory	3	8.6%

Table 3. Dominant learning styles for F-16 pilots (self-assessment).

Composite of Learning Styles. When looking at the composite of all of the 117 respondents to the learning style assessments in over a two year period, almost 60% were either hands-on, or hands-on/visual learners (Table 4).

Learning Style	Number	Percentage
Visual	38	32.5%
Auditory	8	6.8%
Hands-on	52	44.4%
Hands-on/Visual	16	13.7%
Visual/Auditory	3	2.6%

Table 4. Composite of dominant learning styles (n=117).

While a clear majority of the pilots were predominantly hands-on or hands-on/visual learners, the research indicated that most classroom environments were auditory in nature, with visual supplementation, and very little, if any, hands-on learning.

Screening and Selection for Training

Screening pilots prior to entering training should play a important factor in selecting potentially successful pilots for high capital investment flight

training programs. The selective screening of individuals has always been a major factor used by the military, which places pilots with limited flying hours in demanding flying positions. One of the reasons that former military pilots have always occupied a high percentage of the airline cockpits is because the military has always maintained high pilot selection and training standards. Military aviators have to be in good physical condition and most have a 4-year college degree. Additionally, applicants have to be screened to meet related physical and psychological requirements. The pilot selection and testing process is considered a key to the success of military pilot training and includes tests for general cognitive abilities, personality, psychomotor skills, and physical fitness to eliminate individuals who were less likely to succeed (Karp, 1996).

Lufthansa Airlines has been using comprehensive screening programs since the 1950s with tremendous success. Their screening programs have resulted in an exceptionally high pilot training completion rate of more than 90% (Dr. Karsten Severin, Director of Psychology, Lufthansa German Pilots School, personal interview, Bremen, Germany, March 3, 1995). The German Aerospace Research Institute (DLR) has been responsible for the screening for pilots for Lufthansa Airlines for over 40 years. This screening has resulted in a selection criteria such that less than 10% of the applicants who pass the screening fail to complete the flight training. In addition to the physical examinations for entry into pilot training, the DLR screens for knowledge, ability, and personality. "Knowledge" test areas include school grades, English language, mechanical and technical subjects, and numeral facility. "Ability" testing looks at numerical reasoning, memory (auditory and visual), perception and attention, psychomotor coordination, and multiple task capacity. "Personality" screening, on which Lufthansa places a high importance, explores achievement motivation, rigidity, mobility, risk taking, vitality under stress, extroversion, emotional stability, and stress resistance. The DLR contends that if the total profile of knowledge, ability, and personality is at or above their normative group in all areas, the individual has an extremely high probability of being a successful airline pilot (Dr. Klaus-Martin Goeters, Director, Aviation and Space Psychology Department, German Aerospace Research Institute, personal interview, Hamburg, Germany, April 2, 1996).

DEVELOPMENT OF INTEGRATED AVIATION EDUCATION LEARNING MODEL

Using the review of the literature and the data collected from the interviews with the initial group of aviation students, an initial aviation educational model was developed. An evaluation of this aviation education model was conducted in a university class of commercial airline focused instrument flight students over a two-semester academic year.

Integrated Learning Model Components

Adult Education Principles. In line with the adult education model, goals for learning objectives and the methods for knowledge transfer and evaluation were explained in detail by the educator in order to assure a "buy-in" by the learners to the educational process.

Traditional Learning. Using the traditional, competitive learning model, a lecture was delivered on each major instrument flight topic. The educator used a personal computer-based flight simulator program, with a video projector, to visually reinforce the lessons.

Cooperative Learning. Under the cooperative learning model, the learners, in two-person teams, made classroom presentations on subtopics that were *assigned by the educator*. These presentations served as a review of the topics for the entire class, a reinforcement vehicle for the presenters, and a teamwork environment for the learners to practice their group cooperative and interpersonal skills. The learners also used the personal computer-based flight simulator program with a video projector.

Collaborative Learning. The collaborative learning model was used in both the classroom presentations and the personal computer-based flight simulator laboratories. In the collaborative learning classroom setting, the students taught the class an entire topic *as decided by the learner team*. After the classroom presentations had been completed, the two-person teams participated in immediate application collaborative sessions using the personal computer-based flight simulators. In the collaborative learning laboratory, the teams "flew" an entire flight profile using "pilot-flying/pilot-not-flying" procedures. The pilots were then transitioned to Flight Training Devices (FTDs), to include Line-Oriented Flight Training (LOFT) early in the training to reinforce multi-crew concepts and challenge and response checklists and procedures.

Observational Learning. In the collaborative learning laboratory, a non-flying team observed the team that was flying and then provided an assessment of the flight when the lesson was completed. This provided direct, peer feedback for the team who was flying, and objective observational learning for the non-flying team.

Learning Style Theory. Throughout the various stages of learning -- educator lecture, learner cooperative and collaborative presentations, and learner collaborative and observational flight simulator missions -- the material was delivered in visual, auditory, and hands-on learning styles. This was a major component of the model.

Evaluation Findings

The evaluation of the model incorporated interviews, classroom observations, and observations of the students in a personal computer-based flight simulator laboratory (Karp, 1996).

Applied Learning Theories. The students responded very positively to the adult learning paradigm with facilitation and motivation, along with a focus on the students' buying-in to the course objectives, self-directed study, and cooperative and collaborative learning techniques.

Team PC-Based Flight Simulator Programs. The students supported immediate application, using collaborative learning, the strongest. They felt that once they had been exposed to the basic instrument flight information in the classroom, the use of the personal computer-based flight simulator programs was an exceptional reinforcing tool, especially when used in connection with the collaborative team flights. The students also felt that the transition from the PC-based flight simulators to the larger flight training devices was easy and seamless, especially using the FTD's multi-crew checklists and cockpit procedures, which were similar to those used in the PC-based flight simulators.

KEYS TO SUCCESS OF AN INTEGRATED LEARNING MODEL

As a result of the evaluation of the initial aviation education model, an integrated learning process, the *Aviation Education Reinforcement Option* or *AERO model* (See Figure 1), was developed to increase retention and enhance application of aviation education. In addition to the adult learning principles and cooperative and collaborative learning techniques, the model employs extensive use of personal computer-based flight simulator programs to provide immediate application and hands-on training.

There are several keys to the success of such a learning model: The entire integrated aviation learning model must be closely monitored and facilitated by the educator to assure that the agreed upon objectives are met in the desired sequence. Pre-class preparation and self-directed learning, including the use of computer-based training programs, are stressed to maximize learner-educator contact time. The curriculum must be presented by the educator in all learning styles and in a building-block approach, while using increasingly complex material and technology. In addition to the self-directed learning, interactive, cooperative, and collaborative techniques are important to students learning from each other. The learners should be grouped into teams, or *crews*, for student presentations in the classroom, followed immediately by PC-based flight simulator program lessons in a crew learning laboratory. Learners *teaching* other learners the various components of each lesson contributes significantly to long-term retention. Another team of learners should also observe while the student crew is flying the simulator in the learning laboratory. The behavior modeling of both successful and unsuccessful actions, an outgrowth of observational learning theory, is particularly applicable to university-level aviation education when it corresponds to future job related performance.

RESEARCH IMPLICATIONS

1. The majority of major, regional, and commuter airlines, as well as corporate aviation, prefer *time-based* experience, over *proficiency-based* experience, to provide the best model to select a pilot to be hired by the airlines.

2. If aviation academic training is given in conjunction with a similarly developed flight training program focusing on specific airline multi-crew procedures, there exists a high potential to have an enhanced aviation training program which could produce highly qualified pilots for the airlines in less time than the current training path and provide a career path to be hired directly into a regional airline cockpit.

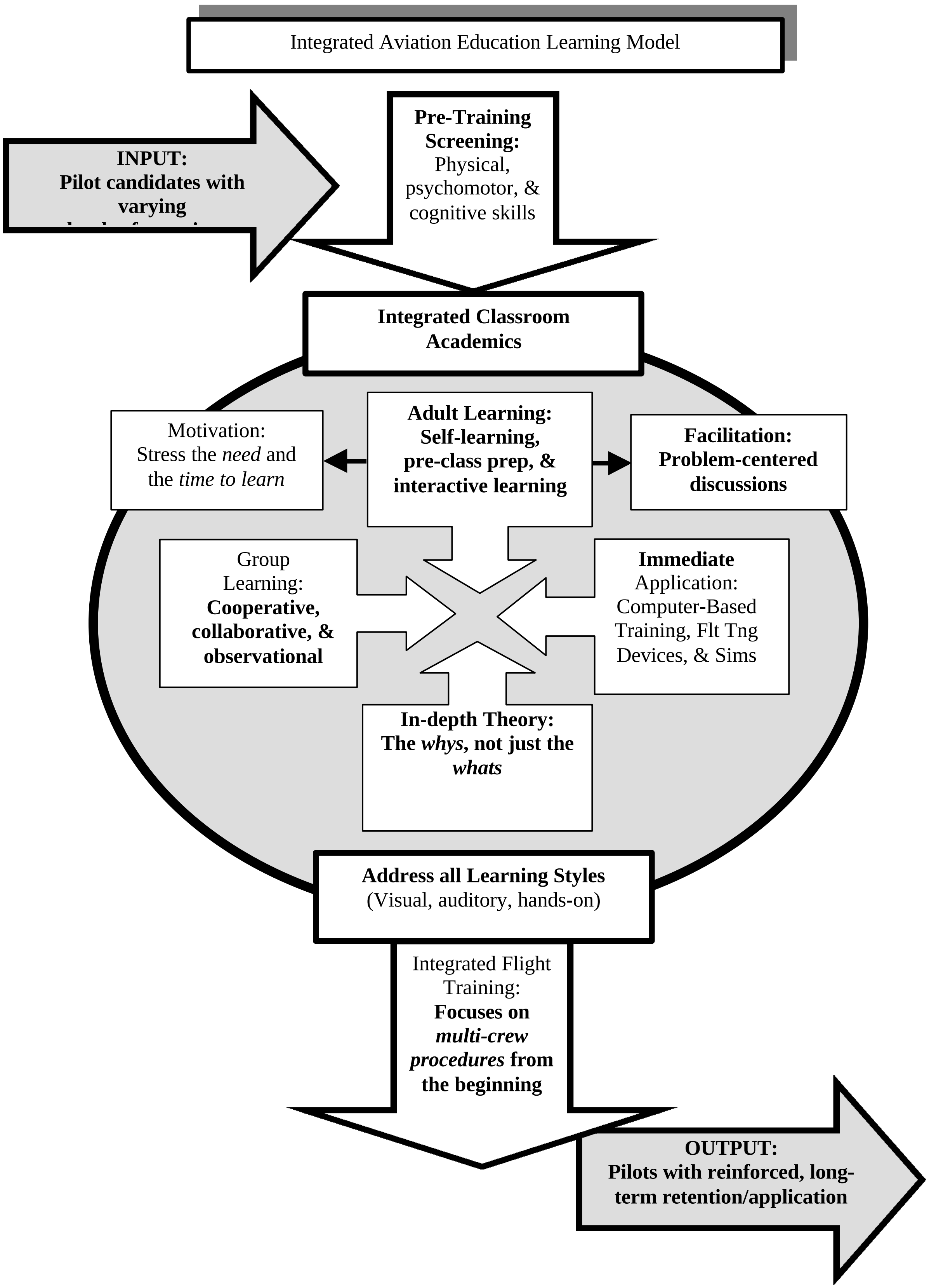
Integrated Aviation Education Learning Model
INPUT:
Pilot candidates with varying
Pre-Training Screening:
Physical, psychomotor, & cognitive skills
Integrated Classroom Academics
Motivation:
Stress the need and the time to learn
Adult Learning:
Self-learning, pre-class prep, & interactive learning
Facilitation:
Problem-centered discussions
Group Learning:
Cooperative, collaborative, & observational
Immediate Application:
Computer-Based Training, Flt Tng Devices, & Sims
In-depth Theory:
The whys, not just the whats
Address all Learning Styles
(Visual, auditory, hands-on)
Integrated Flight Training:
Focuses on multi-crew procedures from the beginning
OUTPUT:
Pilots with reinforced, long-term retention/application

Figure 1. Integrated Aviation Learning Model: ***Aviation Education Reinforcement Option (AERO Model)***

While the classroom lecture format is effective and essential when learners have little or no grounding in the subject or when rules and regulations must be given in detail, facilitation, as well as cooperative and collaborative techniques, are more effective in engaging learners to tap into their experiences and to work and learn together.

3. Cooperative and collaborative learning techniques, which are based on the concept of students' learning by working together on substantive issues, have a high potential for lecture reinforcement and increasing the long-term retention of aviation education information.

4. Behavior modeling, an outgrowth of observational learning theory, is particularly applicable to aviation education because it seeks to change behavior by demonstrating job related actions and providing learning reinforcement.

5. Advancements in flight simulator technology have made important contributions to providing alternatives for expensive high-technology aircraft training. Appropriate simulator training, focused on technical depth and airline procedures, can bridge the gap between basic general aviation training and the operation of high technology aircraft systems.

6. In preparation for pilots training in large flight simulators and highly complex aircraft, computer-based training and PC-based flight simulators can economically increase the efficiency of the ground training and decrease the time required to reach proficiency.

7. Comprehensive pre-training screening for commercial airline pilots, including an examination of cognitive abilities, personality profiles, psychomotor skills, and physical fitness, has a high probability for predicting an individual's potential for success in airline training.

RECOMMENDATIONS

1. Aviation education and training institutions should adopt an integrated aviation learning model, such as the AERO Model in Figure 1, which uses the adult education paradigm and cooperative and collaborative learning techniques, in concert with PC-based flight simulator programs and fight training devices for immediate classroom hands-on application of airline multi-crew cockpit procedures.

2. The U.S. airlines should recognize *proficiency-based training*, in addition to experience-based training, in their criteria for pilot employment application eligibility,

With the projections of shortages of qualified, commercial airline pilots in the U.S. airline industry, the timing is favorable now to make a bold change in employment criteria. This major change need not be addressed by individual airlines alone, but rather should be considered by a coalition of the airline industry, universities with aviation programs, and the federal government.

3. Create an aviation industry, university, and government aviation education and training coalition. This joint coalition would, in an on-going forum, define commercial pilot needs, develop training standards, furnish aviation education and training concepts to provide the industry with the best trained and the safest pilots in the world.

4. Develop a standard national screening program which predicts an individual's potential for success as an airline pilot and assists interested applicants with their decisions on whether or not to pursue careers as airline pilots, prior to making the required capital investment for the training.

CONCLUSION

As aviation technology and the international airspace structure become more complex, aviators must assimilate, on a high retention and application level, an increasing amount of information. An integrated learning model applied to modern aviation education could improve understanding, efficiency, effectiveness, and safety in aviation education and training programs. The incorporation of an integrated aviation learning model should not only have a positive affect on the efficiency and effectiveness aviation training programs, but it should also potentially help ease the projected shortage in the commercial airlines by substituting in-depth, long-term knowledge retention and proficiency for some of the airlines' current flying hour hiring requirements.

The retention of women in aviation programs is an additional factor to consider in meeting future commercial pilot requirements. The full utilization of female resources, as well as male resources, is important. Women constitute only a small percentage of the commercial pilot force, yet they comprise a large resource pool from which the commercial aviation industry can draw. In order to retain the best people in aviation academic programs, aviation academic providers must design their curriculum and delivery vehicles to meet their students' specific learning styles, whether they are male or female.

The investment in time for curriculum development in such a structured, integrated aviation education model should pay high dividends in expanding the learners' knowledge base, enhancing their flexibility to address new situations, and increasing their productivity and effectiveness. An in-depth academic knowledge is critical in aviation because the success of the aviation training is not measured on the bottom line of a balance sheet like many other professions, but it is measured rather in the development of highly effective flight crews, and in safety--the protection of the lives of the flight crews and their passengers.

REFERENCES

Brookfield, S. (1989). Facilitating adult learning. In Merriam and Cunningham (Eds.), Handbook of adult and continuing education. San Francisco: Jossey-Bass.

Bruffee, K. (1995, January/February). Sharing our toys: Cooperative learning versus collaborative learning. Change, 27, 12-18.

Cross, K. (1979). Adult learners: Characteristics, needs, and interests. In Peterson, R. and associates (Eds.), Life learning in America. San Francisco: Jossey-Bass.

Emanuel, R. & Potter, w. (1992). Do Students' style preferences differ by grade level, orientation toward college, and academic major. Research in Higher Education, 33, 395-414.

Filipczak, B. (1995, March). Different strokes: Learning in the classroom. Training, 32, 43-48.

Gilligan, C. (1982). In a different voice. MA: Harvard University Press.

Karp, M. (1996). Theoretical aviation training for future airline pilots. Doctoral Dissertation, Walden University, Minneapolis, MN. UMI 9713644.

Karp, M, Condit, D., Nullmeyer, R. (1999). F-16 Cockpit/Crew Resource Management. (AL/HR-TR-1999-XXXX, in-progress). Mesa, AZ: Air Force Research Laboratory.

Knowles, M. (1980). The modern practice of adult education: From pedagogy to andragogy (2nd Ed). New York: Cambridge Books.

Kozma, R. & Johnston, J. (1991, January). The technological revolution comes to the classroom. Change, 16-18.

Machado, R. (1994, January). A Happy Cockpit: Reducing Cockpit Stress. Flight Training, 5, 50-52.

Matthew, R., Cooper, J., Davidson, N., & Hawkes, P. (1995, July/August). Building bridges between cooperative and collaborative learning. Change, 27, 35-40.

Tannen, D. (1990). You just don't understand: Women and men in conversation. New York: Ballentine Books.

Turney, M. (1995). Women's learning and leadership styles: Impact on CRM. Proceedings of the 21st Conference of the European Association for Aviation Psychology, Volume 1, Applications of Psychology to the Aviation System. Brookfield, Vermont: Ashgate Publishing Company.

United States Department of Transportation Federal Advisory Committee (1993, August). Pilots and aviation maintenance technicians for the twenty-first century: Assessment of availability and quality. Washington D.C.: U.S. Government Printing Office.

Zemke, R. & Zemke, S (1995, June). Adult learning: What do we know for sure? Training, 32, 31-40.